Claims 6-10 are directed to a chamber cleaning method wherein a plasma CVD chamber of a semiconductor integrated circuit protection device is treated with at least one chamber cleaning gas comprising hexafluoropropylene.

It is the Examiner's contention that it would have been obvious to have modified Babacz which discloses a chamber cleaning method using a fluorine containing gas in view of JP '429 which discloses a method of dry etching in the preparation of semiconductor devices using hexafluoropropylene gas. Applicant submits that claims 6-10 are patentable over these references for the reasons set forth below.

The target in etching with a fluorocarbon is mainly SiO_2 and both CF_X (x = 1-3) free radicals and CF_x^+ (x = 1-3) ions are required. CF_x (x = 1-3) free radicals primarily form fluorocarbon thin films, and CF_x^+ (x = 1-3) ions primarily etch SiO_2. CF_3^+ and CF_2^+ ions are preferable as etching species. On the other hand, CF_2 free radical is preferable for forming fluorocarbon thin films.

SiO_2 etching requires the formation of deep and fine patterns. Etching with less microloading and a high selectivity is the most desirable etching, and is conducted by anisotropic etching. In order to gain a high selectivity, fluorine free radicals (F-) formed in plasma should be prevented from reacting with Si or resists. An effective etching is preferably conducted by increasing CF_3^+, and forming dense fluorocarbon thin films on Si and resist with CF_2 free radicals to protect them from fluorine free radicals. Low molecules of fluorocarbon, such as C_3F_6, C_4F_8 and C_2F_4 are known to achieve an effective etching.

Targets in plasma cleaning are mainly silicon compounds, such as SiO_2, polysilicon, and Si_3N_4. Fluorine free radicals formed in plasma are the main cleaning

species. Cleaning is a type of plasma etchings, but it is totally different from the usual etching, or ion assisted etching. In plasma cleaning, ions are not given any energy in plasma, and only free radicals conduct isotropic etching (cleaning) by chemical reactions.

In cleaning, fluorine free radical reacts with silicon compounds to form a fluorine compound with a low boiling point, such as SiF_4, followed by its desorption. Fluorocarbon free radicals even resist the reaction between fluorine free radical and silicon compound. In order to achieve an effective plasma cleaning, fluorocarbon free radicals should be reduced and fluorine free radicals should be formed as much as possible.

A gas suitable for etching is entirely different from a gas suitable for cleaning. This is because the active species are different in the respective techniques. Typically, an etching species is a fluorocarbon species, such as CF_3^+, CF_2^+, and CF^+ ($CF_3^+ > CF_2^+ > CF^+$: etching efficiency), whereas a cleaning species is a fluorine free radical (F-). Accordingly, one of ordinary skill in the art would not expect that an unsaturated fluorocarbon which can be used as an etching gas would work as a cleaning gas as well.

However, the inventors have discovered that unsaturated fluorocarbons are effective in plasma cleaning. Low molecular unsaturated fluorocarbons in particular dissociate in the plasma to form low molecular fluorocarbon free radicals and a small amount of high molecular free radicals. The low molecular fluorocarbon free radicals dissociate into carbon and fluorine (F-) for the most part, and the low molecular fluorocarbon free radicals do not resist the reaction of fluorine free radicals.

JP '429 describes a mixed gas containing unsaturated chain fluorocarbon and unsaturated cyclic fluorocarbon as an etching gas for a semiconductor device. Generally, unsaturated fluorocarbons have been used for etching because they are more likely to form cations such as CF^+, CF_2^+ and CF_3^+ and the like, which are the reactive species in etching.

Gabric, U.S. Patent No. 5,281,302, describes saturated fluoridated carbons, especially C_1 and C_2 (only CF_4 and C_2F_6), as chamber cleaning gases, with which O_2/O_3 may be mixed. Typically, saturated (low molecular) fluorocarbons which contain more fluorine proportions are used for cleaning, because many fluorine free radicals are required as reactive species in cleaning.

For the reasons discussed above, there would have been absolutely no motivation to have combined the teachings of JP '429 and Gabric to achieve the present invention. Therefore, this rejection is clearly inappropriate and should be withdrawn.

Applicant submits that the present application is now in condition for immediate allowance.

Favorable consideration is respectfully requested.

Respectfully submitted,

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